A randomized comparison of the Saphenous Vein Versus Right Internal Thoracic Artery as a Y-Composite Graft (SAVE RITA) trial: One-year angiographic results and mid-term clinical outcomes

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Objective: The Saphenous Vein Versus Right Internal Thoracic Artery as a Y-Composite Graft (SAVE RITA) trial was designed to evaluate the noninferiority of the saphenous vein (SV) compared with the right internal thoracic artery ([R]ITA) used as a Y-composite graft.

Methods: A total of 224 patients who had undergone off-pump revascularization for multivessel coronary artery disease using the SV or RITA as a Y-composite graft based on the in situ left ITA were assigned randomly to the SV Y-composite graft (SV group, n = 112) or free RITA Y-composite graft (RITA group, n = 112). The primary endpoint was the 1-year angiographic patency rate of the second limb conduits (SV or RITA). Postoperative 1-year coronary angiograms were performed in 215 patients (SV group, 108; RITA group, 107).

Results: The overall graft patency rate was 97.4% (745 of 765) at 1 year (97.9% in the SV group vs 96.9% in the RITA group, $P = .362$). The primary endpoint of the study, the 1-year patency rate of the SV composite grafts, was 97.1% (238 of 245) and was noninferior to that of the RITA composite grafts (97.1% [198 of 204]) with a 95% lower confidence limit of −2.6% ($P < .001$ for noninferiority). The graft qualities, evaluated using the FitzGibbon patency grades, were also similar between the 2 groups ($P = .948$). No statistically significant differences were found in the overall survival rates between the 2 groups at 1 and 4 years ($P = .998$). Also, no statistically significant differences were found between the 2 groups in the freedom from major adverse cardiac and cerebrovascular event rates at 1 and 4 years ($P = .597$).

Conclusions: The SV composite grafts were noninferior to the RITA composite grafts in terms of the 1-year angiographic patency rates. (J Thorac Cardiovasc Surg 2014;148:901-8)

Although the saphenous vein (SV) is still a widely used conduit for coronary artery bypass grafting (CABG), lower long-term patency rates and worse clinical outcomes have been reported after CABG performed with SV aortocoronary grafts compared with CABG performed with internal thoracic artery (ITA) grafts.[1,2] Because the lower patency rates of SV grafts result from the structural and functional differences between veins and arteries,[3] various efforts have been made to overcome those limitations.[4-6] A minimal manipulation technique in harvesting the SV has recently been re-emphasized owing to its benefit in preserving the venous endothelial layer.[5,7] The benefits of using the minimally manipulated SV as a composite graft based on the in situ left ITA have been hypothesized to be less exposure of the SV to direct pressure and circulatory stress from the ascending aorta and continuous exposure to the nitric oxide released from the in situ ITA.[8-10]

The Saphenous Vein Versus Right Internal Thoracic Artery as a Y-Composite Graft (SAVE RITA) trial is the first randomized, controlled, clinical trial designed to evaluate the noninferiority of the SV compared with the right ITA (RITA) as a Y-composite graft based on the in situ left ITA. Earlier in the trial, we had demonstrated that SV composite grafts were comparable to RITA composite grafts in terms of early postoperative angiographic graft patency and clinical outcomes.[11] We have since analyzed the primary endpoint of the trial, the 1-year patency rates of the SV and RITA composite grafts, and the midterm clinical outcomes.

METHODS

The SAVE RITA trial was a randomized, controlled, open-label clinical trial. The institutional review board (approval no. H-0803-024-237) approved the study protocol, and all study patients provided informed consent (ClinicalTrials.gov identifier: NCT01051986).

Study Design

The study design and inclusion criteria have been previously described.[11] Patients, aged 40 to 75 years, who were scheduled to undergo off-pump

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Disclosures: Authors have nothing to disclose with regard to commercial support.

Read at the 94th Annual Meeting of The American Association for Thoracic Surgery, Toronto, Ontario, Canada, April 26-30, 2014.

Received for publication Jan 13, 2014; revisions received March 2, 2014; accepted for publication March 12, 2014; available ahead of print June 25, 2014.

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0022-5223/$36.00

http://dx.doi.org/10.1016/j.jtcvs.2014.03.057

Abbreviations and Acronyms

CABG = coronary artery bypass grafting
ITA = internal thoracic artery
MACCE = major adverse cardiac and cerebrovascular events
OPCAB = off-pump CABG
RITA = right ITA
SAVE RITA = Saphenous Vein Versus Right Internal Thoracic Artery as a Y-Composite Graft
SV = saphenous vein

CABG (OPCAB) for multivessel coronary artery disease using a Y-composite graft based on the in situ left ITA were evaluated for eligibility. The exclusion criteria included ineligible Y-composite graft revascularization, an unavailable RITA or SV, left ventricular dysfunction (ejection fraction $\leq 25\%$), chronic renal failure requiring renal replacement therapy, previous cardiac surgery, emergency operation, or a medical history such as malignant disease that might limit the possibility of midterm follow-up. The primary endpoint measurement of the SAVE RITA trial was the 1-year angiographic patency rate of the second limb conduits (SV or RITA). The secondary endpoint measurements were the early postoperative angiographic patency rate of the conduits and midterm clinical outcomes, including overall survival and rates of freedom from cardiac death and major adverse cardiac and cerebrovascular events (MACCE).

Of 511 patients who had undergone first-time isolated CABG from September 2008 to October 2011, the 496 patients scheduled to undergo OPCAB were assessed for eligibility by 1 of us (K-B.K.). The 224 eligible patients who were expected to receive an in situ left ITA-based Y-composite graft for complete revascularization (mean age, 62.7 ± 7.8 years) were assigned randomly to 1 of the 2 study groups in a 1:1 manner, depending on the second limb conduit used for construction of the Y-composite graft: the SV Y-composite graft (SV group, n = 112) or the free RITA Y-composite graft (RITA group, n = 112). Randomization was performed intraoperatively using a web-based block randomization method, controlled by the medical research collaboration center at our institution, with randomly determined block sizes of 4 and 6. The preoperative characteristics and risk factors, including age (SV vs RITA group, 63.3 ± 7.8 vs 62.8 ± 8.0 years, $P = .647$), hypertension (80 [71.4%] vs 76 [67.9%], $P = .561$), diabetes (47 [42.0%] vs 51 [45.5%], $P = .590$), and 3-vessel disease (90 [80.4%] vs 87 [77.7%], $P = .623$) were mostly similar and comparable between the 2 groups (Table 1). Of the 224 patients, 9 (4.0%) were excluded from the 1-year postoperative angiographic evaluation; 5 patients (2.2%) were withdrawn because of intraoperative protocol violations, 1 patient died in the early postoperative period, and 3 patients refused to undergo the 1-year angiographic follow-up examination. The 1-year (12.6 ± 2.0 months) angiographic graft patency rates were evaluated in 215 patients (98.6%; SV group, 108; RITA group, 107) of the 218 patients who had undergone OPCAB as planned and had survived (Figure 1).

Operative Strategies

The basic surgical procedures and principles of OPCAB have been previously described.[7,11]

The left and right ITAs were both harvested using a skeletonization technique. The greater SV was harvested from a lower leg after systemic heparinization. The manipulation and tension of the SV were minimized during harvest, and manual intraluminal dilatation was avoided. Immediately after the second limb conduit (SV or RITA) was harvested, it was anastomosed to the side of the left ITA without any pharmacologic treatment. After the Y-composite graft had been constructed, the distal end of the second limb conduit was clamped with an atraumatic bulldog clamp. The left anterior descending coronary artery territory was revascularized first, using the left ITA, and the second limb conduit was left to be dilated spontaneously by the native flow and pressure of the left ITA. The left circumflex coronary artery territory was then revascularized, followed by the right coronary artery territory. A sequential anastomotic technique was used when >2 coronary arterial anastomoses were needed. When the length of 1 or both limb conduits of the Y graft was not sufficient to reach the target vessels, an additional SV segment from the other lower leg (the third limb conduit) was harvested to lengthen the graft limb in an I-shape. The average number of distal anastomoses per patient (SV vs RITA group, 3.5 ± 0.9 vs 3.6 ± 0.8, $P = .769$) and per the left ITA (SV vs RITA group, 1.2 ± 0.5 vs 1.2 ± 0.5, $P = .585$) was similar between the 2 groups. The number of distal anastomoses in the 3 coronary artery territories was also similar between the 2 groups, as reported in our earlier analysis.[11] However, the number of distal anastomoses using the second limb conduit was smaller in the RITA group than in the SV group (1.9 ± 0.7 vs 2.3 ± 0.8, $P < .001$), and the third limb conduit to lengthen the graft limb was needed more frequently in the RITA group than in the SV group (n = 40 vs n = 4, $P < .001$).

The patients were given an initial dose of heparin (1.5 mg/kg) and periodic supplemental doses to maintain an activated clotting time of >300 seconds. All patients took aspirin until the day of surgery and resumed it as soon as possible after surgery, usually at 1 day postoperatively. If the patient had a high blood level of low-density lipoprotein cholesterol (>100 mg/dL) postoperatively, drug therapy was initiated.

Evaluation of Endpoints

The graft patency was graded in the manner described by FitzGibbon and colleagues.[12] Grades A (excellent) and B (fair) were treated as patent. Grade O anastomosis, which included stenosis of ≥75% of the vessel diameter or a totally occluded graft, was treated as occluded. One physician, who was unaware of this clinical trial, initially reviewed all the coronary angiograms, and consensus was reached after review. The patients underwent regular postoperative follow-up examinations through the outpatient clinic at 2- or 3-month intervals and were interviewed by telephone for confirmation of their condition if the last clinic visit had not been conducted at the scheduled point. The clinical and angiographic follow-up examinations were completed on December 31, 2012. The follow-up data were complete for all survivors, with a median follow-up duration of 34 months (range, 4 to 52). Cardiac death was defined as any death related to cardiac events, including sudden death during the follow-up period. The MACCE included cardiac death, angina recurrence, ST-segment elevation and non–ST-segment elevation myocardial infarction, coronary reintervention (including redo-CABG), and cerebrovascular accident (defined as new and sudden-onset neurologic deficits lasting >24 hours with no apparent nonvascular causes).

Statistical Analysis

The study was designed to have 80% power with a 1-sided type I error of 5% and a noninferiority margin of −8%. The 1-year patency rates were expected to be 93% in the SV and 95% in the RITA grafts. A total of 194 anastomoses using the second limb conduit were required in each group. Because no correlation was assumed between the distal anastomoses in each patient, 97 patients in each group were needed to complete the study cohort when using an estimated average number of 2 distal anastomoses per conduit. Allowing for a 3% withdrawal rate in the perioperative period and 10% during 1-year follow-up period, it was calculated that 112 patients would be needed in each group.

Statistical analysis was performed using the Statistical Package for Social Sciences software package, version 12.0 (SPSS, Inc, Chicago, Ill). Data are expressed as the mean ± standard deviation or proportions. The

TABLE 1. Baseline demographic data and risk factors

Variable	SV group (n = 112)	RITA group (n = 112)	*P* value
Age (y)	63.3 ± 7.8	62.8 ± 8.0	.647
Female gender	30 (26.8)	21 (18.8)	.152
Risk factors			
Smoking	57 (50.9)	53 (47.3)	.593
Hypertension	80 (71.4)	76 (67.9)	.561
Diabetes mellitus	47 (42.0)	51 (45.5)	.590
Dyslipidemia	19 (17.0)	14 (12.5)	.346
Overweight (BMI ≥ 25 kg/m^2)	51 (45.5)	51 (45.5)	>.999
History of stroke	13 (11.6)	18 (16.1)	.333
Unstable angina	83 (74.1)	84 (75.0)	.878
Left main disease	41 (36.6)	43 (38.4)	.783
Three-vessel disease	90 (80.4)	87 (77.7)	.623
Logistic EuroSCORE (%)	3.2 ± 2.5	3.3 ± 2.7	.710
LVEF (%)	58.0 ± 9.7	56.2 ± 9.2	.172

BMI, Body mass index; *EuroSCORE*, European system for cardiac operative risk evaluation; *LVEF*, left ventricular ejection fraction; *SV*, saphenous vein; *RITA*, right internal thoracic artery.

unit of analysis was an anastomosis, under the assumption that each anastomosis would be independent from each other in each patient. Comparisons between the 2 groups were made using the chi-square test and Fisher's exact test for categorical variables and the Student *t* test for continuous variables. The time-to-event outcomes were analyzed using Kaplan-Meier survival curves, and comparisons between the 2 groups were performed using the log-rank test. The primary endpoint was analyzed as the proportion of difference with the 95% 1-sided confidence interval, to test for the noninferiority hypothesis. The *P* value was calculated using a z-test method. The null hypothesis was that the SV graft was inferior to the RITA graft based on the 1-year angiographic patency rate, with a noninferiority margin of −8%. The clinical outcomes were analyzed using the "intention-to-treat" approach in all 224 study patients. The angiographic patency rates were compared using a "per-protocol" analysis in 215 patients, because the endpoint was the patency rate of the distal anastomoses using the second limb conduit.

RESULTS

One-Year Postoperative Angiographic Results

In the 215 patients (108 in the SV group; 107 in the RITA group), who were evaluated using the 1-year angiograms, the overall graft patency rate was 97.4% (745 of 765) at 1 year postoperatively (97.9% [375 of 383] in the SV group vs 96.9% [370 of 382] in the RITA group; $P = .362$; Figure 2). The 1-year patency rate of the distal anastomoses using the second limb conduit was 97.1% (238 of 245) in

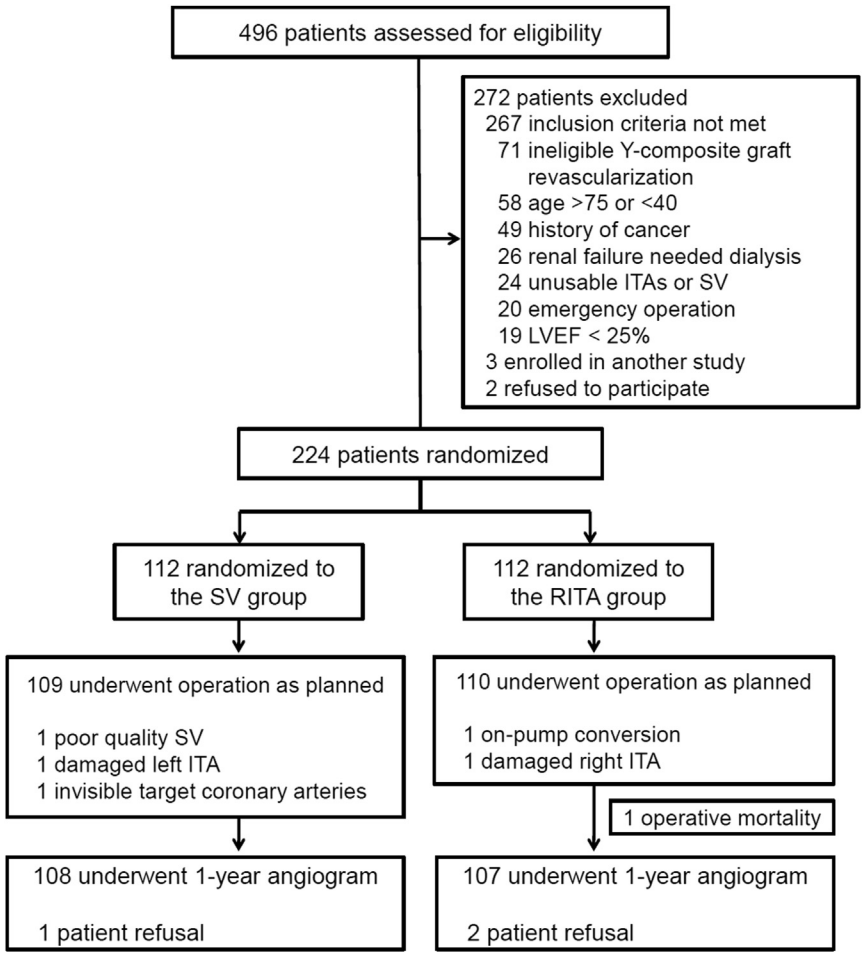

FIGURE 1. Summary flow diagram of participants. *ITA*, Internal thoracic artery; *SV*, saphenous vein; *LVEF*, left ventricular ejection fraction; *RITA*, right ITA.

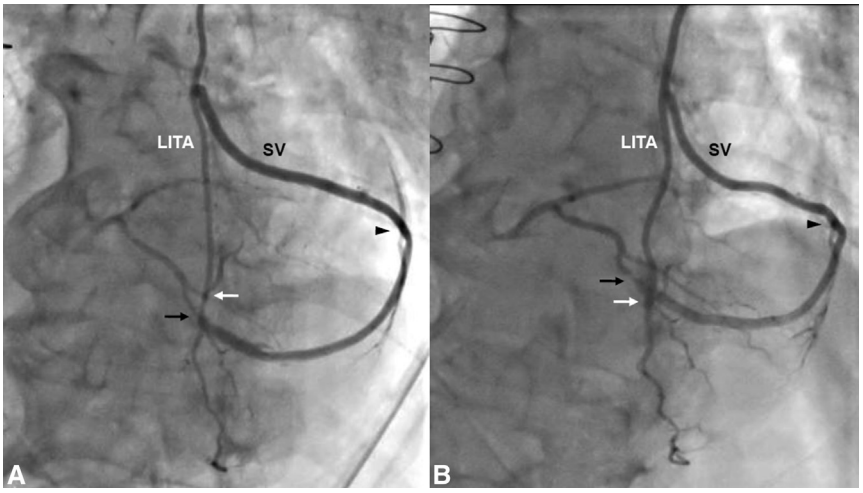

FIGURE 2. Patent saphenous vein (*SV*) Y-composite grafts based on the in situ left internal thoracic artery (*LITA*) on (A) early postoperative and (B) 1-year angiograms in a 74-year-old male patient. The in situ LITA was anastomosed to the left anterior descending coronary artery (*white arrow*), and the SV was anastomosed to the obtuse marginal coronary artery (*black arrowhead*) and right posterolateral coronary artery (*black arrow*) using a sequential anastomotic technique.

the SV group and 97.1% (198 of 204) in the RITA group, a difference that was 0% within the 95% 1-sided confidence interval of −2.6% to ∞. The lower confidence limit was greater than the noninferiority margin (−8%), with $P < .001$ for the test of noninferiority in the 1-year patency rate of the SV to the RITA (Table 2). When the second limb conduit patency rates were compared according to the target coronary artery territories, no statistically significant differences were found in the patency rates between the 2 groups, although the SV group showed a trend toward a lower patency rate in the right coronary artery territory than in the other coronary territories ($P = .082$; Table 3). One SV composite graft showed stenosis of ≥50% at the Y-anastomosis site at 1 year postoperatively, although it was widely patent on the early postoperative angiogram.

Comparison of Anastomotic Qualities

When the graft patency grades were evaluated in the manner described by FitzGibbon and colleagues,[12] the proportion of grade A, B, and O of the in situ left ITA grafts at 1 year was not statistically different between the 2 groups. Those of the second limb conduits were also not statistically different between the 2 groups at 1 year postoperatively (Table 4).

Overall and Cardiac Death–Free Survival Rates

One operative death occurred in the RITA group. Of the 223 survivors, late death occurred in 3 (1.3%); 2 in the SV group (1 cardiac death and 1 pneumonia) and 1 death from malignancy in the RITA group. The overall survival rate at 1 and 4 years was 99.6% and 97.7%, respectively, without a statistically significant difference ($P = .998$). The freedom from cardiac death rate was not compared between the 2 groups because only 1 event occurred during the follow-up period.

Freedom From MACCE

During the study period, 12 patients (4 in the SV group; 8 in the RITA group) experienced angina recurrence. Percutaneous coronary intervention was performed in 4 patients in the RITA group. The indications for percutaneous intervention were occlusion of the left ITA graft in 1, occlusion of the RITA graft in 1, and progression of the native coronary artery disease in 2. Redo-CABG was performed in 1 patient in the SV group at 21 months postoperatively. Although the bypass grafts were all patent, progression of native coronary artery disease created the need for reoperation. The freedom from reintervention rate at 1 and 4 years postoperatively was 100% and 98.5%, respectively, without a statistically

TABLE 2. One-year angiographic patency rates of distal anastomoses

Variable	Total (n = 215)	SV group (n = 108)	RITA group (n = 107)	*P* value
Overall grafts	745/765 (97.4)	375/383 (97.9)	370/382 (96.9)	.362*
Grafts using LITA	263/263 (100)	134/134 (100)	129/129 (100)	—
Grafts using second conduit	436/449 (97.1)	238/245 (97.1)	198/204 (97.1)	<.001†
Grafts using third conduit	46/53 (86.8)	3/4 (75.0)	43/49 (87.8)	.443‡

Data presented as n/total (%). *SV*, Saphenous vein; *RITA*, right internal thoracic artery; *LITA*, left internal thoracic artery. **P* value using chi square test for inequality. †*P* value using z-test for noninferiority. ‡*P* value using Fisher's exact test for inequality.

TABLE 3. Comparison of 1-year patency rates for distal anastomoses performed with second limb conduits between saphenous veins and right internal thoracic arteries according to coronary artery territories

Variable	SV group (n = 108)	RITA group (n = 107)	*P* value
Total	238/245 (97.1)	198/204 (97.1)	.958
LAD territory	46/47 (97.9)	42/42 (100)	>.999
LCX territory	121/122 (99.2)	115/119 (96.6)	.209
RCA territory	71/76 (93.4)	41/43 (95.3)	>.999
P value	.082	.207	—

Data presented as n/total (%). *SV*, Saphenous graft; *RITA*, right internal thoracic artery; *LAD*, left anterior descending coronary artery; *LCX*, left circumflex artery; *RCA*, right coronary artery.

significant difference between the 2 groups (100% and 98.9% in the SV group vs 99.1% and 95.3% in the RITA group, $P = .177$). Two patients experienced stroke events, 35 and 48 months after surgery. None of the patients experienced acute myocardial infarction. The freedom from MACCE rate at 1 and 4 years postoperatively was 97.8% and 92.8%, respectively, without a statistically significant difference between the 2 groups (97.3% and 94.4% in the SV group vs 98.2% and 91.1% in the RITA group, $P = .597$; Figure 3). The freedom from the composite endpoints of 1-year graft occlusion and MACCE at 1 and 4 years postoperatively was also similar between the 2 groups (89.3% and 87.2% in the SV group vs 89.2% and 83.2% in the RITA group, $P = .594$).

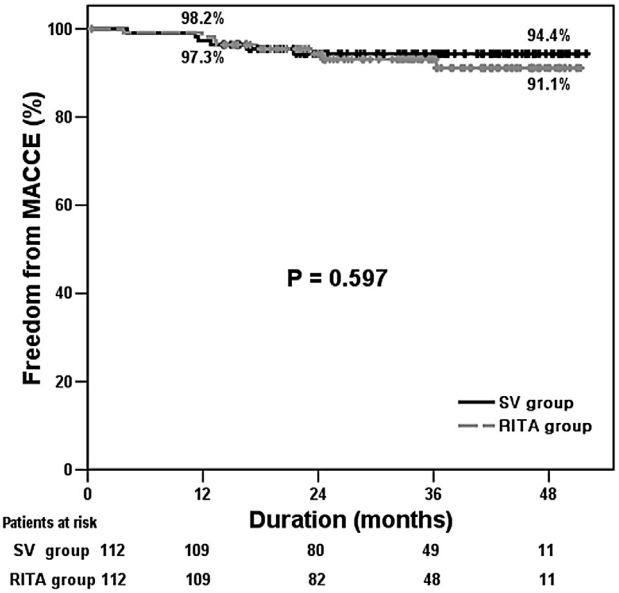

FIGURE 3. Comparison of freedom from major adverse cardiac and cerebrovascular events (*MACCE*) between the saphenous vein (*SV*) and right internal thoracic artery (*RITA*) groups.

DISCUSSION

The SAVE RITA trial revealed 2 main findings. First, the 1-year angiographic patency rate of the SV used as a Y-composite graft based on the in situ left ITA was noninferior to that of the RITA composite graft. Second, the clinical results of OPCAB using SV composite grafts showed no statistically significant difference compared with those of OPCAB using the RITA composite grafts up to 4 years after surgery in terms of overall survival and MACCE-free survival rates.

TABLE 4. Comparison of anastomotic qualities between SV and RITA groups on 1-year angiograms

Conduit	FitzGibbon grade	SV group (n = 108)	RITA group (n = 107)	*P* value
LITA				.440
	A	132/134 (98.5)	125/129 (97.0)	
	B	2/134 (1.5)	4/129 (3.0)	
	O	0/134 (0)	0/129 (0)	
Second limb conduit (SV or RITA)				.948
	A	232/245 (94.7)	192/204 (94.1)	
	B	6/245 (2.4)	6/204 (2.9)	
	O	7/245 (2.9)	6/204 (2.9)	

SV, Saphenous vein; *RITA*, right internal thoracic artery; *LITA*, left internal thoracic artery.

Poor long-term patency rates and clinical outcomes have been reported after CABG performed with SV aortocoronary grafts compared with CABG performed with ITA grafts.[1,2,13,14] From the experience using left ITA grafts, arterial grafts have been thought to be better conduits than SV grafts, and many trials have compared the patency rates of the radial artery and SV, with conflicting results.[15,16] In contrast, the RITA has been considered a second conduit of choice after the left ITA, because of its freedom from atherosclerotic changes, excellent long-term patency, and improved long-term survival rate.[17,18] The SAVE RITA trial is the first randomized, controlled, open-label clinical trial designed to evaluate the SV compared with the RITA as a second limb conduit anastomosed to the side of the in situ left ITA. Our noninferiority hypothesis was developed from the improved SV patency rates reported in recent studies.[5,19,20] In our previous retrospective study,[19] we demonstrated that the 1-year patency rate of the SV composite grafts was 92.1%, similar to the patency rate of arterial composite grafts using the RITA and right gastroepiploic artery (91.0%). From these results, the 1-year patency rate of the SV composite graft was estimated as 93% in the present trial. Similarly, the 1-year patency rate of the RITA composite graft was estimated as 95% from our previous study, demonstrating 94.0% and 94.1% patency rates of the RITA grafted to the left circumflex and right coronary artery territories, respectively.[21]

The structural and functional properties of the SV could explain the propensity of SV grafts to undergo relatively early occlusion compared with ITA grafts.[1] Of the various processes known to mediate SV graft occlusion, vessel wall injury, which results from mechanical trauma and/or exposure to arterial pressure, is regarded as a key factor. Numerous efforts to preserve the structure and function of the venous endothelium, including technical modifications of SV harvesting, rigorous application of secondary prevention methods, and modification of lifestyle factors, have been made to overcome the limitations of SV grafts.[7,22,23] However, recent trials have still demonstrated unsatisfactory patency rates for the SV (89% at 1 year and 81.4% at 5 years) harvested with conventional methods and used as aortocoronary bypass grafts.[16,24] In the SAVE RITA trial, the SV tension was minimized during harvest, and manual intraluminal dilatation was avoided. In addition, we used the SV as a second limb conduit to construct the Y-composite graft. The theoretical advantages of using the SV as a Y-composite graft over an aortocoronary bypass graft include that the SV conduit anastomosed to the side of the left ITA is exposed to less circulatory stress than a conduit anastomosed to the ascending aorta; that the SV composite graft is exposed continuously to endothelium-protective substances such as nitric oxide produced from the left ITA[8,11]; and that complications such as embolic stroke and aortic dissection could be reduced by avoiding aortic clamping for proximal anastomosis. The additional benefits of using SV composite grafts compared with bilateral ITA composite grafts are that the RITA, the second conduit of choice after the left ITA, is reserved for later redo CABG; that the risk of perioperative morbidity, such as sternal infection, which can occur after bilateral ITA use, is decreased; and that the length of the SV is preserved compared with aortocoronary SV grafts, because the SV from a unilateral lower leg will be enough for complete revascularization in most patients with multivessel coronary artery disease when using a sequential anastomotic technique.

In the early results of the SAVE RITA trial, we demonstrated that SV composite grafts were comparable to RITA composite grafts in terms of early angiographic patency and postoperative clinical outcomes (1 in-hospital mortality in the RITA group; 1 mediastinitis in the SV group).[11] The patency rates of the SV composite grafts in the SV group showed no statistically significant differences compared with the patency rates of the RITA composite grafts in the RITA group (98.8% [245 of 248] vs 99.5% [207 of 208]; $P = .629$). The trial results demonstrated that the 1-year angiographic patency of the SV composite graft was noninferior to that of the RITA composite graft. The difference was 0%, and the lower margin of the confidence interval was −2.6%, a sufficiently smaller difference than the prespecified noninferiority margin of −8% to reject the null hypothesis. The SV grafted on the right coronary artery territory showed a lower patency rate than that grafted on the left coronary artery territory, but the difference was not statistically significant. Although we did not evaluate factors, such as the minimum coronary artery lumen diameter and maximal coronary artery stenosis, a large diameter of the right coronary artery with a moderate degree of stenosis might cause a lower patency rate in the right coronary artery territory. Another possible explanation is that revascularization of the right coronary artery territory using an SV composite graft needs a longer SV graft with valves inside, which could cause blood stasis and thrombus formation, particularly in situations causing competitive flow. This requires additional investigation.

The differences in the midterm clinical outcomes, including overall survival and freedom from cardiac death, and freedom from MACCE, were also not statistically significant between the 2 groups.

Study Limitations

The present study had limitations that must be recognized. First, the present study was not a multicenter ''all-comers'' study, although it was a prospective, randomized, controlled trial. The study should be performed as a multicenter-based trial to overcome the institutional factor. Second, the 1-year graft patency rates and clinical outcomes with a median follow-up duration of 34 months did not provide sufficient data to reach a definite conclusion on the noninferiority of the SV composite graft compared with the RITA composite graft. It will be necessary to extend our patency study up to several years after surgery and analyze the long-term clinical outcomes to demonstrate that the advantages of SV composite grafting are sufficient to overcome the previously published advantages of the RITA over the SV as an additional conduit.

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Discussion

Dr Sary F. Aranki *(Boston, Mass).* I have nothing to disclose. This is the fourth study in this meeting that addresses the theme of more arterial revascularization and the use of bilateral internal mammary arteries in patients undergoing CABG surgery. Dr Kim and his colleagues just presented the only study that was a randomized controlled study. They previously published graft patency rates at 1 day. Now, they present the 1-year angiographic data for 98% of their randomized patients. In addition, they also report on the 1- and 4-year clinical outcomes.

Their major findings were that if the SV graft is used as a Y-composite graft from the left internal mammary artery (LIMA), it is as good, or noninferior, as a free RIMA graft deployed in the same fashion regarding the 1-year patency and 1- and 4-year outcomes. Therefore, I interpret these results to indicate that a SV graft from the LIMA is as good as a bilateral internal mammary artery. These results are too good to be true. However, I congratulate Dr Kim and his team on a study well done and a well-written and clear report.

Dr Kim, I am very nervous every time I use the LIMA as the sole source of coronary blood supply in patients with 3-vessel disease. I believe that the LIMA is so valuable that it should be used preferentially for the left anterior descending artery; no sharing. However, the results speak for themselves. I have the following questions for you.

Question 1. How do you determine preoperatively and intraoperatively whether the LIMA is going to have adequate blood flow to sustain the entire coronary circulation?

Dr Kim. Thank you, Sary, for your nice comments and good questions. We have performed CABG using a Y-composite graft based on the left ITA single inflow in most of our patients since mid-2000. Although a concern exists that construction of a Y-composite graft based on the left ITA single inflow may not supply sufficient blood flow to a wider area of myocardium, we are not able to decide it preoperatively or intraoperatively.

In our previous study, we compared the degree and time course of myocardial perfusion improvement between the bilateral in situ ITAs group and the Y-composite group using the myocardial single photon emission computed tomography performed preoperatively and at 3 months and 1 year after surgery. We published the data in the *Journal of Thoracic and Cardiovascular Surgery* in 2007. Our data demonstrated that revascularization with a Y-composite graft or bilateral in situ ITAs graft exhibited a complete recovery of stress perfusion and a similar pattern of reversibility improvement until 1 year after surgery. Therefore, we suggest that revascularization using a Y-composite graft based on the left ITA single inflow might be sufficient to supply the whole heart.

Dr Aranki. Okay. My second question. There were 245 distal anastomoses with the vein graft versus 204 in the RITA group. Was this difference significant and did those patients have more complete revascularization?

Dr Kim. As I presented in my slides, the average length of the harvested RITA was shorter than that of the SV harvested from a lower leg. Therefore, the average number of distal anastomoses using the RITA was smaller than that of distal anastomoses using the SV. When the length of the Y-composite graft was not sufficient for complete revascularization, an additional SV segment was harvested to lengthen the conduit. In the RITA group, an additional SV segment was harvested in 40 patients and connected to the RITA for complete revascularization. Therefore, the average number of distal anastomoses per patient was similar between the 2 groups.

Dr Aranki. The next question, and the last. Currently, only 20% of coronary bypass operations are done as OPCAB in the United States. What would your advice be to surgeons who perform on-pump CABG? Do you advise them to do a Y-vein graft to the LIMA in those patients, too, or just for OPCAB patients?

Dr Kim. My answer is yes. We also performed on-pump CABG using the SV composite graft. I would like to recommend using the SV composite graft for both off-pump and on-pump CABGs. There are several advantages using the SV composite graft over the aortocoronary bypass graft.

First, the SV conduit may be exposed to less circulatory stress than a conduit anastomosed to the ascending aorta. Second, the SV conduit anastomosed to the left ITA is exposed continuously to endothelium-protective substances such as nitric oxide produced from the ITA. Third, complications such as embolic stroke and aortic dissection could be reduced by avoiding additional aortic clamping for proximal anastomosis during on-pump CABG.

Dr Aranki. Thank you, Dr Kim.

Dr John D. Puskas *(New York, NY).* No disclosures. Dr Kim, I am impressed with your study. I congratulate you and your colleagues for excellent surgical results and the rigor to embark and complete a prospective randomized trial; I know how difficult that is.

I was also impressed by your answers and your thoughts of why the vein might actually do so well coming off the ITA. There might be another possible explanation. I noticed that you chose the lower leg vein, which would naturally be smaller in caliber than the upper thigh vein and would match your ITA somewhat better. You also harvested that vein using an open technique with minimal manipulation. I think it is very important, in general, how we harvest our conduits and that they be harvested in an atraumatic way; whether opened or closed, they should be atraumatically harvested.

Do you think that might be 1 reason in this short follow-up, the vein was performing as well as a RITA? Is it the harvest technique you used for the vein that improves its function and makes it perform similar to an RITA?

Dr Kim. Whenever harvesting the SV, it is very important to prevent inadvertent SV injury. It might be one of the factors for our improving patency results with SV composite grafting.

Dr Puskas. Do you dilate the veins under pressure with a syringe?

Dr Kim. No, we do not manually dilate the SV after harvesting. The SV harvest was initiated after systemic heparinization. It was performed using an atraumatic, open technique, so that manipulation was limited to the perivascular tissue, leaving the surrounding adipose tissue in place. Immediately after the SV was harvested, it was used to construct a Y-composite graft.

Dr Puskas. I agree with all of those points. How do you construct your anastomosis between the lower leg atraumatically harvested SV and the ITA? Do you make a T or a Y?

Dr Kim. I always perform a Y-anastomosis using an 8-0 polypropylene continuous suture technique.

Dr Puskas. Congratulations on your study.

Dr Brian F. Buxton *(Melbourne, Australia).* I think this is an excellent study, and I do not know of any or very few other randomized trials comparing the RITA with the SV, with exception of only one other.

Now the question is, when I first had the privilege of being a primary discussant with your study, I think it was 2 years ago, I wondered why at the time you chose to use an off-pump technique rather than conventional anastomoses from the aorta. However, having looked at the brilliant results that you have had with Y-grafting and off-pump surgery, I now fully understand.

The question I really want to ask you is, what are the power calculations? Is 112 patients in each group enough to give you a long-term result?

Dr Kim. We have to extend our patency study up to several years after surgery and analyze the long-term clinical outcomes.

Dr A. Pieter Kappetein *(Rotterdam, The Netherlands).* The other part of the question was did you perform a sample size calculation?

Dr Kim. The study was designed to have 80% power to detect 1-year patency rates of 93% in the SV versus 95% in the RITA grafts, with a noninferiority margin of −8%. A total of 97 patients were required in each group.

Allowing for a 3% withdrawal in the perioperative period and a 10% withdrawal during 1 year of follow-up, it was calculated that recruitment of 112 patients was needed in each group.

Dr Buxton. An inferiority calculation is somewhat difficult, and this is going to test the statistics of that calculation.

But the other issue is, having been down this road before, looking at the long-term results after changing a technique in coronary artery bypass surgery, I am still struggling after 10 years, because the changes are very slow to evolve. Thus, I think 1 year is going to be the first of a number of study periods, possibly even as long as 5 or 10 years.